

## TECHNICAL MEMORANDUM

**Date:** December 12, 2016  
**To:** Jason Maughan  
**From:** Michael Klisch and David Banton  
**cc:** Paul Pigeon – GAI Denver  
**Project No.:** 913-1101-010.002  
**Company:** P4 Production L.L.C.  
**Email:** dbanton@golder.com  
**RE: TOTAL PHOSPHORUS ANALYTICAL DATA**

This technical memorandum presents total phosphorus analytical data from selected surface water, spring, and groundwater locations in and around the P4 Production L.L.C. (“P4”) Soda Springs Plant (“Plant”). The analytical data are from the following locations:

- Non-contact cooling water discharge to Soda Creek
- Soda Creek upstream and downstream of the non-contact cooling water discharge
- Springs in the vicinity of Plant
- Plant Production Wells
- Monitoring wells reflecting background groundwater quality

### 1.0 ANALYTICAL BACKGROUND

The total phosphorus data are from samples collected between October 1991 and June 2016, or starting when the samples were first collected for sample locations added after 1991. These samples were collected, analyzed, and validated under Work Plans and Quality Assurance Project Plans (“QAPPs”) prepared as part of the Phase I and II Remedial Investigation/Feasibility Studies and subsequent annual groundwater and surface water sampling events (e.g. Golder Associates Inc. 1991; 1992; 2015). Samples were also collected prior to October 1991, however, the samples were not collected, analyzed, and validated under the procedures described in the Work Plans and QAPPs and are not presented here.

Samples collected for total phosphorus analysis are unfiltered, and preserved with sulfuric acid in the field upon sample collection. Following sample collection, the samples are stored on ice or in a secure refrigerator until shipment on ice to the analytical laboratory under chain of custody.

Samples were analyzed by several analytical laboratories since 1993. The laboratories have included:

- Analytical Resources Inc. (1991 through 2000)
- IAS Envirochem (2001 and 2002)
- SVL Analytical (since 2003)



Analytical methods for total phosphorus have varied since 1991. The analytical methods have included the following:

- EPA 365.1/365.2 with a detection limit of 0.10 milligram per liter (mg/L) – through 2006
- SM4500-P-E with a detection limit of 0.10 mg/L – since 2006

## 2.0 ANALYTICAL RESULTS

This section describes the analytical results for total phosphorus.

### 2.1 Non-Contact Cooling Water Discharge

The non-contact cooling water discharge to Soda Creek is sampled at the NPDES outfall. The non-contact cooling water discharge was sampled in October 1991; no further samples were collected until June 2000. Since June 2000, the non-contact cooling water discharge to Soda Creek has been sampled annually in the spring.

A triplicate sample is collected from the outfall (with the exception of 2000 when a single sample was collected).

The total phosphorus results for the non-contact cooling water discharge samples are summarized on Table 1.

### 2.2 Soda Creek and Irrigation/Power Canal

Samples are collected from Soda Creek above and below the non-contact cooling water outfall and the irrigation/power canal diversion weir at the following locations shown on Figure 1:

- Upstream – at the Soda Up (SC-01) station about 250 feet upstream of the outfall, collected since 2001.
- Downstream – at the irrigation and power diversion weir station (SC-02) about 60 feet downgradient of the outfall (collected since 2005).
- Downstream – in the flow-impacted reach of Soda Creek and above the return of power diversion water to Soda Creek; and station Soda Down (SC-04) located about 3,780 feet downgradient of the diversion flashboards (collected since 2001).
- Irrigation/Power Canal – about 3,730 feet downstream of the outfall, and about 830 feet upstream of the power canal return to Soda Creek (station PR-01), collected since 2010.

The total phosphorus results for the surface water sites are summarized on Table 2.

Note: substantially all of the flow in Soda Creek is diverted by flashboards into the irrigation and power canal weir. The majority of the flow in the impaired segment of Soda Creek is from local spring discharge.

## 2.3 Springs

Samples have been periodically collected from springs that represent background water quality. These springs include the following springs shown on Figure 1:

- Soda Creek
  - Hooper Spring – a sodic spring located west of the Plant and upgradient of the non-contact cooling water outfall. The spring discharges about 1 to 2 cubic feet per second (cfs) into Soda Creek. Hooper Spring was sampled in 1991, 1992, and from 1998 to 2000.
  - Marsh Spring - a sodic spring located west of the Plant and upgradient of the non-contact cooling water outfall. The spring discharges about 0.1cfs that flows into the flow-impaired reach of Soda Creek. Marsh Spring was sampled beginning in 2011.
  - Doc Kackley Spring – a sodic spring located southwest of the Plant and upgradient of the non-contact cooling water outfall. The spring discharges less than 0.1 cfs into Soda Creek. Doc Kackley Spring was sampled in 1991 and 1992.
- Ledger Springs (A, B, and C) – these three springs are located southeast (and downgradient) of the Plant and discharge a combined 4 cfs. The spring water flows towards the Bear River. Ledger Springs are used by the City of Soda Springs for water supply. One or more of the Ledger Springs has been sampled in 1991, 1992, and from 1998 to 2000.
- Formation Spring – a large spring located northeast (and upgradient) of the Plant that discharges an estimated 20 cfs. Formation Spring was sampled in 1991. Formation Spring water infiltrates into the basalt bedrock a short distance downgradient of the spring.

The total phosphorus results for the springs are summarized on Table 3.

## 2.4 Plant Production Wells

Monsanto operates three production wells (PW-01, PW-2, and PW-03) to supply process water and non-contact cooling water and one well (PW-04) to supply potable water (Figure 1). Production well PW-03 is operated continuously to supply water to the Plant; either PW-01 or PW-02 are operated intermittently as needed to provide additional water to the plant. PW-01, PW-02, and PW-03 are located within the central portion of the Plant while PW-04 is located upgradient of Plant facilities and operated intermittently to meet demand. The Plant production wells have been sampled annually since 1991 unless a well is offline for repairs.

The total phosphorus results for the Plant production wells are summarized on Table 4.

## 2.5 Background Groundwater


Information on total phosphorus concentrations in groundwater are provided by several monitoring wells north and east of the site. In addition, Plant production well PW-04 is upgradient of the Plant site and also provides information on background groundwater quality. The background monitoring wells include the following wells shown on Figure 1:


- **North of Plant:** SO<sub>2</sub> North, TW-13, TW-14, TW-15, TW-28, TW-29, TW-57, and PW-04
- **East of Plant:** TW-31, TW-32, and TW-33

The background monitoring wells are completed at various depths within the basalt aquifer system including the Upper and Lower Basalt Zones.

The total phosphorus results for the background wells are summarized on Table 5.

**GOLDER ASSOCIATES INC.**

  
Michael Klisch, LHG  
Senior Project Hydrogeologist

  
David Banton, LHG, RG  
Principal Hydrogeologist

MK/DB/ks

**List of Tables**

Table 1	Total Phosphorus – Non-contact Cooling Water Outfall
Table 2	Total Phosphorus – Surface Water
Table 3	Total Phosphorus – Springs
Table 4	Total Phosphorus – Plant Production Wells Groundwater
Table 5	Total Phosphorus – Background Groundwater

**List of Figures**

Figure 1      Sample Location Map

### 3.0 REFERENCES

Golder Associates Inc. (Golder). 1991. Phase I Remedial Investigation/Feasibility Study Work Plan for the Soda Springs Elemental Phosphorus Plant. October 10.

Golder. 1992. Phase II Remedial Investigation Work Plan, Monsanto Elemental Phosphorus Plant, Soda Springs, Idaho. Rev. 1. December 14.

Golder. 2015. Groundwater and Surface Water Sampling Work Plan, Monsanto Soda Springs Idaho Plant. April 28.

## TABLES

**Table 1: Total Phosphorus - Non-Contact Cooling Water Outfall**

Sample Date	Total Phosphorus (mg/L)	Qualifier
October 25, 1991	1.06	
October 25, 1991	1.06	
October 25, 1991	1.08	
June 11, 2000	1.30	
May 25, 2001	1.75	
May 25, 2001	1.75	
May 25, 2001	1.76	
June 15, 2002	1.13	J
June 15, 2002	1.16	J
June 15, 2002	1.16	J
July 12, 2003	0.77	
July 12, 2003	0.72	
July 12, 2003	0.78	
June 25, 2004	0.93	
June 25, 2004	0.93	
June 25, 2004	0.93	
July 10, 2005	0.77	J
July 10, 2005	0.78	J
July 10, 2005	0.78	J
August 9, 2006	0.98	
August 9, 2006	0.98	
August 9, 2006	0.98	
June 23, 2007	0.76	
June 23, 2007	0.76	
June 23, 2007	0.76	
June 17, 2008	0.98	
June 17, 2008	0.99	
June 17, 2008	0.98	
September 24, 2008	0.95	
September 24, 2008	0.83	
September 24, 2008	0.95	
May 31, 2009	1.29	
May 31, 2009	1.28	
May 31, 2009	1.28	
May 23, 2010	1.2	
May 23, 2010	1.22	
May 23, 2010	1.21	
May 24, 2011	2.58	
May 24, 2011	2.57	
May 24, 2011	2.62	
July 18, 2011	0.991	J
July 18, 2011	0.989	J
July 18, 2011	0.994	J
June 13, 2012	0.963	
June 13, 2012	0.976	
June 13, 2012	0.954	
June 7, 2013	0.476	J
June 7, 2013	0.48	J
June 7, 2013	0.507	J
June 13, 2014	0.548	
June 13, 2014	0.559	
June 13, 2014	0.563	
May 17, 2015	1.24	D
May 17, 2015	1.13	D
May 17, 2015	1.21	D
June 2, 2016	0.843	
June 2, 2016	0.834	
June 2, 2016	0.819	

Notes:

1. Sampled in triplicate except June 11, 2000
2. Data Qualifiers:
  - D - a dilution was applied
  - J - estimated result

Table 2: Total Phosphorus - Surface Water

SC-01 Soda Up			SC-02 Soda at Weir			PR-01 Power Canal			SC-04 Down		
Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier
May 25, 2001	0.11		July 10, 2005	0.10	J	May 25, 2010	2.61		May 25, 2001	0.060	
June 15, 2002	0.16	J	August 9, 2006	0.18		May 24, 2011	0.144		May 25, 2001	0.070	
July 12, 2003	0.05		June 23, 2007	0.11		May 24, 2011 (s)	0.156		June 15, 2002	0.094	J
June 25, 2004	0.08		June 17, 2008	0.19		May 24, 2011 (s)	0.10		July 12, 2003	0.030	
July 10, 2005	0.07	J	September 23, 2008	0.10		July 18, 2011	0.278	J	June 25, 2004	0.03	
August 9, 2006	0.09		May 31, 2009	0.17		June 13, 2012	0.133		July 11, 2005	0.12	J
June 23, 2007	0.08		May 23, 2010	0.13		June 7, 2013	0.096	J	August 10, 2006	0.08	
June 17, 2008	0.14		May 24, 2011	0.162		June 13, 2014	0.100		June 25, 2007	0.07	
September 24, 2008	0.14		July 17, 2011	0.077	J	May 17, 2015	0.161		June 17, 2008	0.16	
May 31, 2009	0.12		June 13, 2012	0.076		June 2, 2016	0.186		September 23, 2008	0.62	
May 23, 2010	0.09		June 8, 2013	0.099					May 31, 2009	0.27	J
May 24, 2011	0.08		June 13, 2014	0.069					May 24, 2010	0.26	
May 24, 2011 (d)	0.07		May 17, 2015	0.138					May 25, 2010 (d)	0.26	
July 17, 2011	0.069	J	June 2, 2016	0.091					July 18, 2011	0.082	J
July 17, 2011 (d)	0.062								June 13, 2012	0.076	
June 13, 2012	0.086								June 8, 2013	0.357	J
June 7, 2013	0.106	J							June 13, 2014	0.150	
June 13, 2014	0.084								June 13, 2014 (s)	0.134	
May 17, 2015	0.087								May 17, 2015	0.061	
June 2, 2016	0.087								June 10, 2016	0.098	

- Notes:
- 1. (d) - duplicate sample
  - 2. (s) - split sample
  - 3. Data Qualifiers:
    - D - a dilution was applied
    - J - estimated result



Table 3: Total Phosphorus - Springs

Doc Kackley			Formation Springs				Hooper Spring			Ledger Springs				Marsh Spring		
Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Spring	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Spring	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier
October 25, 1991	0.37	U	October 24, 1991	A	0.10	U	October 20, 1991	0.27	U	October 24, 1991	A	0.10	U	May 22, 2011	0.31	
May 28, 1992	0.32		October 24, 1991	B	0.10	U	May 26, 1992	0.27		October 24, 1991	B	0.10	U	June 13, 2012	0.25	
			October 24, 1991	C	0.10	U	June 1, 1998	0.13		October 24, 1991	C	0.10	U	June 7, 2013	2.38	J
							June 22, 1999	0.26		May 29, 1992	C	0.10	U	June 12, 2014	0.46	
							June 11, 2000	0.28		June 2, 1998	C	0.02	U	May 17, 2015	3.67	D
										June 28, 1999	C	0.02		June 10, 2016	0.154	
										June 11, 2000	C	0.16				

Notes:  
1. (d) - duplicate sample  
2. (s) - split sample  
3. Data Qualifiers:  
    U - not detected  
    D - a dilution was applied  
    J - estimated result

**Table 4: Total Phosphorus - Plant Production Wells Groundwater**

PW-01			PW-02			PW-03			PW-04		
Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier
October 16, 1991	1.14		October 16, 1991	0.54	U	October 15, 1991	0.49	U	October 16, 1991	0.10	U
May 28, 1992	1.18		May 28, 1992	0.48		May 12, 1992	1.28		May 11, 1992	0.08	J
May 6, 1996	0.98		May 8, 1996	0.48		May 6, 1996	0.43		May 1, 1996	0.07	
June 2, 1998	1.50		June 17, 1997	0.56		June 10, 1997	0.51		June 13, 1997	0.07	
June 22, 1999	1.20		June 2, 1998	0.71		May 30, 1998	0.49		May 30, 1998	0.08	
June 7, 2000	1.00		June 28, 1999	0.54		June 26, 1999	0.43		June 22, 1999	0.09	
May 24, 2001	0.97		June 7, 2000	1.70		June 7, 2000	1.60		June 6, 2000	0.07	
June 12, 2002	1.12	J	May 24, 2001	1.15		May 24, 2001	Lab Error	R	May 22, 2001	0.09	
July 10, 2003	0.87		June 12, 2002	0.33	J	June 12, 2002	0.54	J	June 13, 2002	0.14	J
June 22, 2004	0.77		July 10, 2003	0.30		July 10, 2003	0.30		July 10, 2003	0.02	U
July 11, 2005	1.27	J	June 22, 2004	0.27		June 22, 2004	0.28		July 10, 2003	0.06	
August 14, 2006	0.92		July 11, 2005	0.28	J	July 11, 2005	0.33	J	June 21, 2004	0.07	
June 24, 2007	0.87		August 14, 2006	0.29		August 12, 2006	0.42		July 8, 2005	0.07	J
June 22, 2008	1.10		June 24, 2007	0.3		July 10, 2007	0.47		August 8, 2006	0.07	
June 1, 2009	1.26	J	June 22, 2008	0.41		June 17, 2008	0.46		June 19, 2007	0.11	
May 24, 2010	1.20		June 1, 2009	0.48	J	May 30, 2009	0.46		June 17, 2008	0.06	
May 21, 2011	1.36		May 24, 2010	0.55		May 19, 2010	0.42		May 30, 2009	0.09	
June 8, 2013	1.21		May 21, 2011	0.624		May 19, 2011	0.391		May 19, 2010	0.07	
June 11, 2014	1.04	D	June 9, 2012	0.795		June 8, 2012	0.505		May 17, 2011	0.077	
May 15, 2015	0.659		June 8, 2013	0.589		June 8, 2013	0.375	J	June 5, 2012	0.071	
June 1, 2016	0.959		June 11, 2014	0.365		June 11, 2014	0.314		May 30, 2013	0.098	
			May 15, 2015	0.208		October 8, 2015	0.648		June 5, 2014	0.06	
			June 1, 2016	0.361		June 1, 2016	0.711		May 16, 2015	0.077	

**Notes:**

- (d) - duplicate sample
- (s) - split sample
- Data Qualifiers:
  - D - a dilution was applied
  - J - estimated result
  - R - the data were rejected because of serious QA/QC issues
  - U - not detected

[illegible]

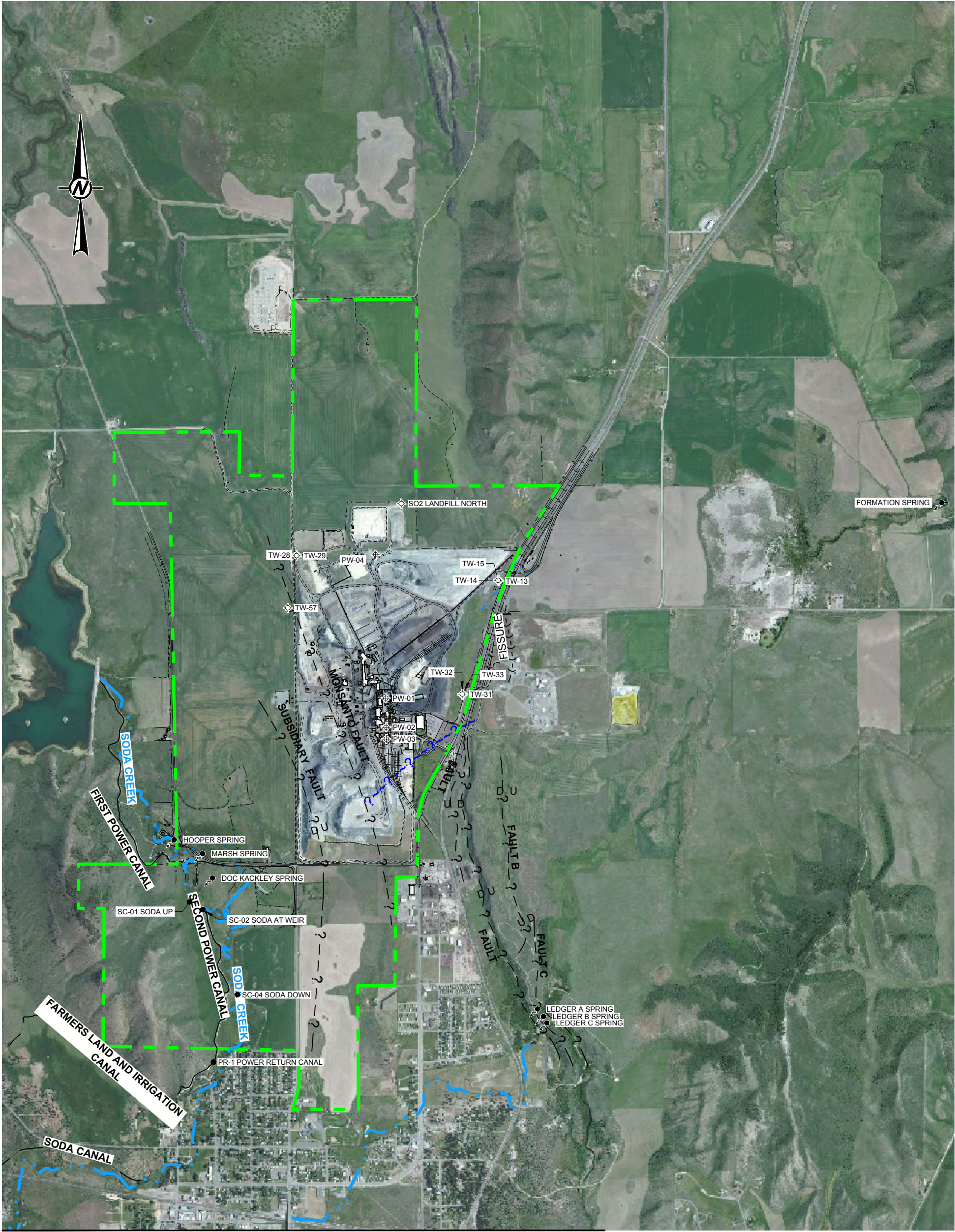
1. (d) - duplicate sample
2. (s) - split sample
3. Data Qualifiers:
  - D - a dilution was applied
  - J - estimated result
  - U - not detected

Table 5: Total Phosphorus - Background Groundwater

TW-57 (UBZ-2γ5)			SO2 Landfill North (UBZ-4γ3)			TW-31 (UBZ-4γ5)			TW-32 (LBZ)			TW-33 (UBZ-4γ3)		
Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier	Sample Date	Total Phosphorus (mg/L)	Qualifier
November 18, 1992	0.59		July 12, 2005	0.07	J	May 27, 1992	1.94		October 26, 1991	1.06		October 22, 1991	1.06	
May 6, 1996	0.17		August 9, 2006	0.07		May 27, 1992	0.96		May 27, 1992	1.42		May 27, 1992	1.02	
June 16, 1997	0.19		June 19, 2007	0.07					May 27, 1992	1.40		November 13, 1992	1.36	
June 1, 1998	0.11		June 19, 2008	0.06					November 16, 1992	1.60		May 3, 1996	0.46	
June 27, 1999	0.18		May 29, 2009	0.07	J				November 16, 1992	1.66		June 13, 1997	0.32	
June 11, 2000	0.17		May 19, 2010	0.08								May 31, 1998	0.34	
May 25, 2001	0.16		May 19, 2011	0.136								June 26, 1999	0.30	
July 13, 2003	0.19		June 6, 2012	0.078								June 26, 1999 (d)	0.32	
June 25, 2004	0.22		May 31, 2013	0.073								June 8, 2000	0.19	
July 8, 2005	0.18	J	June 8, 2014	0.064								May 23, 2001	0.44	
August 13, 2006	0.19		May 8, 2015	0.064								June 14, 2002	0.31	
June 22, 2007	0.18		June 2, 2016	0.089								July 10, 2003	0.220	
June 22, 2008	0.18		June 2, 2016 (d)	0.092								June 23, 2004	0.24	
September 24, 2008	0.11											June 23, 2004 (d)	0.24	J
May 30, 2009	0.16											June 23, 2004 (s)	0.236	
May 20, 2010	0.17											July 8, 2005 (d)	0.51	
May 19, 2011	0.166											July 8, 2005	0.21	
June 8, 2012	0.179											July 8, 2005 (s)	0.22	
June 5, 2013	0.162											August 14, 2006	0.24	J
June 10, 2014	0.182											August 14, 2006 (s)	0.222	J
May 15, 2015	0.159											August 14, 2006 (d)	0.22	J
June 5, 2016	0.170											June 21, 2007	0.19	
												June 21, 2007 (d)	0.20	
												June 21, 2007 (s)	0.648	
												June 21, 2008	0.19	
												June 1, 2009	0.18	
												June 1, 2009 (d)	0.17	
												June 1, 2009 (s)	0.566	
												May 24, 2010	0.17	
												May 24, 2010 (s)	0.05	
												May 24, 2010 (d)	0.17	J
												May 20, 2011	0.154	
												May 20, 2011 (d)	0.161	
												May 20, 2011 (s)	0.14	
												May 20, 2011 (s)	0.17	
												June 11, 2012 (s)	0.158	
												June 11, 2012	0.16	
												June 11, 2012 (d)	0.157	
												May 31, 2013	0.16	
												May 31, 2013 (s)	0.16	
												May 31, 2013 (d)	0.786	
												June 8, 2014 (d)	0.152	J
												June 8, 2014	0.142	J
												June 8, 2014 (d)	0.17	J
												May 9, 2015	0.157	
												June 4, 2016	0.129	
												June 4, 2016 (d)	0.120	
												June 4, 2016 (s)	0.138	

**FIGURE**





LEGEND	
	FAULT
	FISSURE
	GROUNDWATER ZONE
	INSTITUTIONAL CONTROL BOUNDARY
	CREEK
	POWER CANAL
	IRRIGATION CANAL
	GROUNDWATER FLOW REGION BOUNDARY
	SURFACE WATER LOCATION WITH NAME
	MONITORING WELL LOCATION WITH NAME
	SPRING LOCATION WITH NAME
	PRODUCTION WELL LOCATION WITH NAME

NOTES

- NAD83 IDAHO STATE PLANES, EAST ZONE, US FOOT.
- AERIAL PHOTO FROM GOOGLE EARTH (8/2/2013) AND COURTESY OF BING, MICROSOFT CORPORATION

CLIENT  
P4 PRODUCTIONS L.L.C.

PROJECT  
NPDES PERMIT SUPPORT

CONSULTANT



YYYY-MM-DD	2016-12-09
PREPARED	REDMOND
DESIGN	-
REVIEW	MK
APPROVED	DB

TITLE  
SAMPLE LOCATION MAP

PROJECT No.  
913-1101-010.002

Rev.  
A

FIGURE  
2

NOT FOR CONSTRUCTION

